CITIZENS PLANNING ASSOCIATION OF SANTA BARBARA COUNTY, INC.
916 Anacapa Street, Santa Barbara, CA 93101
phone 805-966-3979 fax 805-966-3970
http://www.citizensplanning.org info@citizensplanning.org

REVIEW OF DWR's DRAFT OF THE STATE WATER PROJECT DELIVERY RELIABILITY REPORT

By: Arve R. Sjovold
Co-Chair, Citizens Planning Association's Water Committee
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Introduction

According to the Draft, DWR intends this report to be used to help local planners and water districts and purveyors that depend on SWP water to meet the requirements of the Kuehl and Costa bills, which mandate certain findings before large developments are allowed to move ahead. Specifically, a local water purveyor must certify that he has sufficient, reliable supplies of water to meet the requirements of a proposed development before that development is given a permit. This report is intended to provide the estimates of SWP delivery reliability to serve that purpose.

To develop quantitative estimates of delivery reliability, DWR has developed in concert with the CVP a computer "simulation" of the entire Central Valley system which they exercise under several scenarios to perform the calculations. The calculations yield a frequency diagram for the likelihood of delivering a specified annual amount of water for export to the SWP. Many assumptions are made in fulfilling these calculations.

Although referred to as a "simulation," the ensemble of computer models includes a simulation of the hydrology of the Sacramento Valley, a linear program to determine the limits of constraints in the Delta to establish how much of the available water may be exported, and various other sub-models that are employed to study important issues in more detail, such as some of the salinity models for the Delta. It is probably not accurate to refer to the export calculations as the result of a "simulation." Furthermore, the entire ensemble has never been calibrated against the historical record, an indispensable exercise if the calculated results are to have any validity. Nevertheless, DWR has persisted in the notion that they do not necessarily need any calibration and they refer to the fact that they have performed a "verification" on the simulation of the Sacramento Valley hydrology. **This is not sufficient for the purposes of reliability estimation which requires that absolute accuracy be established, preferably through a calibration against the historical record. More specifically, we find the following deficiencies in the report:**

1) DWR's definition of reliability is incorrect by any standard definition

2) **DWR's frequency diagram is an incorrect interpretation of the statistical characteristics of the underlying hydrologic record that drives its calculations. It has no analytic relevance whatsoever.**

3) **The ensemble of computer programs referred to as a "simulation" has never been calibrated to the historical record. This is unacceptable in a model which must rely on verification of its absolute accuracy**

4) **DWR makes unwarranted assumptions about the capabilities of local entities to store water to equalize wet and dry year deliveries.**

All of these findings require that this report be reconsidered until proper calculations have been performed, peer reviewed, and reported objectively.

Definition of Reliability

DWR defines reliability as "how much one can count on a certain amount of water being delivered to a specific place at a specific time." This is of course not a rigorous definition of reliability. DWR goes on to explain that, "Objectively, water delivery reliability indicates a particular amount of water that can be delivered with a certain numeric frequency." This too is not rigorous. What DWR then offers is a frequency diagram that is based on the variability of water availability evident in a 73 year historical record. This record therefore shows only the extreme high and low years in that record; the likelihood of extremes beyond those in the historical record are not taken into account with the net result that there is no assurance that this frequency calculation is conservative.

The particular interpretation of this frequency calculation by DWR is of the form that a given amount of water can be delivered X % of the time. In their particular reference wherein they state that the SWP is "75% reliable," they really mean that 75% of the Table A amounts can be delivered 50% of the time. The reliability inherent in this interpretation is more correctly stated as 50%, not 75%, which means that there is a 50% chance that this amount of water will not be delivered. 50% is the measure of the reliability; 75% of Table A is the objective. Using other values of water delivered, the frequency diagram can be used to deduce the corresponding values of reliability by DWR's definition. For example, if one desires to be reasonably conservative and chooses, say 90% for "reliability" he finds that only 25% to 30% or more can be counted on.

All of these interpretations assume that the individual points making up the diagram are statistically independent; that is, they really represent an input string of annual flows that can be shown to be truly random. This is of course not the case as we generally understand weather and water in California.

The record clearly shows periods of drought and wetness that are not in accord with a statistically random record. Our last drought was 6 years long and caused severe water shortages throughout California. The DWR calculated frequency diagram does not capture at all the effect of droughts or wet periods. The report does show the calculated results for several of the droughts of record and it becomes quite clear that if one believed that 75% of Table A can be delivered 50% of the time that he would be quite mistaken during one of the droughts. DWR's own simulations summarized in the report show that during the worst 6 year drought only 40% of Table A amounts can be delivered on average. If each receiving entity of SWP would specify its requirements for delivery it would be clear that the general frequency diagram offered by DWR has no relevance whatsoever. Besides misconstruing the definition of reliability, it also fails to acknowledge the variable character of water availability in California.

Balancing Wet and Dry Years

It should be clear to all purveyors that their particular requirements for SWP deliveries all vary significantly. Most importantly, their abilities to get through droughts varies significantly. The ability of individual purveyors to balance wet weather potential deliveries against drought episode shortages is determined by each purveyor's capability to store excesses in time of plenty against periods of drought. These are matters under the control of the individual purveyors, not at all under the control of DWR. **So it is somewhat presumptuous of DWR to declare what the reliability of delivery is for individual purveyors.** The ability of a specific purveyor to balance wet year deliveries against dry years is very specific to the purveyor and entails facilities that are totally under the control of the purveyor and not DWR. The best that DWR can do to help local purveyors ascertain water supply reliability is to offer delivery capabilities over a wide range of local conditions. **This report falls far short of that requirement.**

The conditions of drought are the most stressful for local purveyors. The degree of stress is determined by the dependence they place on SWP deliveries. If for example, a purveyor depends **totally** on SWP water, that is, it is his only source, then his greatest concern is what can be delivered in any given year. According to DWR's calculations that could be as low as 19%. If on the other hand the problem were getting through a 6 year drought, the reliability, according to DWR, would be about 40%. These are of course DWR's definitions of reliability which are really average deliveries over these respective drought time spans, one year and six years.

The question that is posed is what determines a local purveyor's reliance on SWP. Clearly, it is his ability to use other sources of supply at his disposal and his ability to store wet year deliveries for use in drought periods. These capabilities vary immensely among purveyors and the DWR report makes no references to these capabilities. So how can DWR proclaim what delivery reliability is for any given purveyor? Without explicit inclusion of local capabilities in the calculations it is impossible.

The criticisms above all deal with DWR's misinterpretations of "reliability" and the fact that they do not take into account local capabilities which are indispensable to any calculation of reliability to be used by local planning authorities. There is still the question of how good the "simulation" tools are.

Simulation Methodology

As noted above the DWR "simulation" is really an ensemble of computerized tools developed to calculate the amount of water that can be exported from the Delta in a given year. The calculations use the 73 year runoff record in the Central Valley to capture the extremes of conditions likely to be encountered in operating the SWP as well as the CVP. The only portion of these calculations that is truly a simulation is the hydrology of the Sacramento Valley. Here DWR has gone to great pains to simulate the likely runoff to the Delta from a given annual precipitation input and the expected withdrawals, consumptive uses, and return flows occurring in the valley for a given level of development. The simulations accept as givens the gauged runoffs of the main streams as they exit the mountains, an amount of flow that dominates the inputs. The simulation tries to **mimic** the withdrawals that farmers make and the expected losses from those withdrawals and the consequent return flows. These are important determinations, especially during dry years when there is little excess runoff. **How they calibrate these effects is not discussed in their report.**

From previous presentations on DWR's predecessor simulation, DWRSIM, it was shown how the simulation comes quite close in its long term averages to the actual measured flows into the Delta for the 73 years in the record. What was not shown is how they can know for each year what the "measured flow" is into the Delta. It is also of interest that DWR's attempt to verify its simulation cites the estimate of flow into the Delta in 1983, the peak year, as 69 million acre-feet per year. In another DWR document, the EIR for the "State Water Project Supplemental Water Purchase Program", the annual flow into the Delta for that year is cited as 62 million acre-feet per year. The importance of this estimate is vital because the verification runs show that the simulations reproduce this estimate with very high accuracy, perhaps more so than any other point in the simulation. **If the lower estimate is more correct it indicates that the simulation may have significant bias.**

Because the 1983 total runoff into the Delta as calculated by the simulation is in such close correspondence to the value maintained by DWR as the measured value, leads to the speculation that DWR may have used the 1983 point as a calibration standard. This might be okay if they knew for sure what the measured flow into the Delta was that year but it is highly unlikely that in 1983 they could have measured all the flows into the Delta. In particular, in that unprecedented flood year, it is hard to imagine that they could have measured the flows across the Yolo Bypass or even the through the Sacramento Ship Canal not to mention all the small creek flows into the Delta that usually can be ignored in a normal or dry year. It becomes quite clear that for estimating SWP ability to deliver when it is really needed, that is, in dry periods, corroboration of extreme flood events is not the issue. Because DWR steadfastly refuses to disclose how it calibrates its simulation let alone its refusal to calibrate its ensemble of models, it is very difficult to have any confidence in these results. **If the results in the report are to have any value they must be accompanied by documentation demonstrating the simulation's ability to reproduce the historical record and the simulation must be given peer review.**

Another concern with the simulation and the verification results that DWR has disclosed in the past is the failure to demonstrate accuracy in reproducing monthly flows. It is clear that the capability to pump from the Delta is tightly circumscribed by the State Water Resources Control Board (SWRCB). These constraints are actually articulated in numbers of days of allowable pumping at specified maximums if certain conditions prevail. Clearly, the amount of water that can be pumped depends critically on the state of many of the simulation's variables that are expected to vary from day-to-day if not month-to-month. What use then is a verification presentation that only shows that annual flows are reproduced within an acceptable fidelity? **If the simulations were calibrated properly, such calibrations should show that they can reproduce the monthly, or even daily, flows with sufficient fidelity to allow confidence in its ability to predict what can be delivered within the SWRCB constraints to the contractors. The SWRCB constraints should be the guide in calibration so that the model can produce fidelity during those time when pumping is allowed.**

The annual amounts that the simulation calculates and are available to the contractors are actually the result of what the simulation calculates for certain critical monthly periods when the SWRCB rules allow pumping. It is significant to note that the ordinary peak monthly flow which occurs in May is also the period when most pumping is restricted. Accordingly, May is not so important to the calculation of how much can be pumped but it certainly is important if one is only interested in showing correspondence with the annual record. By this means, the simulation may appear to do well on annual calculations while its record for monthly flows can vary significantly in the critical months when pumping is allowed. **In short, DWR must show accurate reproduction of monthly flows if this simulation is to be useful at all for export calculations.**

The export calculations are the result of exercising a linear program which delineates the constraints imposed by the SWRCB. Within those constraints the export model is used to maximize the amounts to be exported. It is typical of a linear program to define a domain of allowable solutions and the objective function determines which of the potential solutions is selected. It is possible that within those same export constraints the model could generate a quite different set of solutions if the objective function were stated as "determine the export flows given a maximum Delta flow desired for fishery health." In other words, the objective function reflects the priorities among the possible solutions. In this instance, it favors only exports.

The same observation may be made of some of the critical flow parameters used in the hydrology simulation of the Sacramento Valley. From what has been learned to date, it seems that some diversion parameters may be set to favor water going to the Delta rather than for use in the Valley.

It is also observed that the hydrology does not clearly distinguish the priority of diversions in the Valley. It is well known that there is a large set of riparian diverters whose water rights precede those of the CVP and SWP. Therefore, it would seem to be a matter of extreme interest to keep track of these priority users in the simulation and report their diversions as a specific category. This is not done so there is little insight as to how dry and critically dry deliveries are affected by these prior rights. And more importantly, it should be of paramount interest how these priority demands are met on a monthly basis.

The essence of the claims by these prior rights holders in the Valley is that their claims effectively truncate the historical hydrologic record such that what remains after serving the prior rights is what the CVP and SWP must work with. The effect is a marginal hydrologic record with much greater variation as the input to the export calculations.

One of the most significant diversions in the Valley is for rice farming, a very water intensive crop. It is also a characteristic of this crop that withdrawals are much greater than actual consumptive use such that a large amount of this withdrawn water is returned to the river. However, the timing of return may be several months after withdrawal which, because of the aggregate amounts involved in rice farming, may affect the simulation significantly. **Our understanding of the simulation is that it does not treat this effect with any fidelity.**

There are many aspects of the simulations that deserve analysis beyond the **meager discussion** in the report. Most are essential to establish how faithfully the simulation can reproduce known data. This is usually done when the simulation is calibrated, an effort for which this simulation (or model) is deficient. This is the **accepted method** of demonstrating the computer model's absolute accuracy, an indispensable requirement if it is to be used to calculate delivery reliability. **This report should not be circulated further; it should in fact be withdrawn until the model has had calibration and peer review.**

The Role of Local Facilities

One of the most significant errors in DWR's logic involves the implicit assumptions it makes regarding the use of unstated local facilities. **Most specifically, the simulation makes the assumption that if the model says the water can be pumped from the Delta and there is capacity in the aqueducts to deliver it to local entities demanding it as part of their Table A amount, then that water is added to the annual total that DWR maintains it can deliver reliably.**

In many instances, the water that is said to be available at a given time really can't be used to meet final demand as seen by the local contractor. The simulation just assumes that the local entity has some means to store water that is immediately available so that it can be used when demanded. In this way the model implicitly assumes that wet year deliveries can always be balanced against dry year deliveries; that is the only way the model can show a 75 or 76% capability. It is also the basis for the unbelievable conclusion that the only reason the project has not delivered more water in the past is because it wasn't demanded. In other words, if more water is demanded the project will deliver more. This is certainly not its history.

Table 1 has been developed from data appearing in the reliability report and from DWR's bulletin series 130. The table presents in the first column the annual requests from the contractors, according to bulletin 130, for the years 1992 through 2000. The second column displays the actual Table A deliveries as shown in Appendix D of the reliability report. Columns 3 and 4 present the simulation results for demands and deliveries as shown in Appendix B, Table B-3, of the report. Only 3 years, 1992-1994, of data from Table B-3 correspond to the Appendix D record of historical deliveries.

Table 1
Comparison of Requests, Actual Deliveries,
And simulated Demands and Deliveries
(Millions of acre-feet/year)

Water Year	Requests	Actual Del	Simul. Demand	Simul. Del
1992	3.630	1.376	3.880	1.199
1993	3.846	2.093	3.559	3.505
1994	3.841	1.749	3.739	3.272

1995	3.164	1.889		
1996	2.687	2.206		
1997	2.977	2.291		
1998	3.335	1.607		
1999	3.419	2.521		
2000	3.617	2.705		
Avgs.	**3.391**	**2.049**	**3.726**	**2.659**

What is immediately clear from the data shown in Table 1 is that the simulation is not very accurate when compared to the historical record. It also demonstrates that the notion that the contractors have not asked for enough water is disingenuous. If the year 1991 had been included the results would have been even worse. Furthermore, the simulation results in the last two columns are based on DWR's year 2001 hydrology and level of development, which is close enough in time to the period of interest so that differences in predicted levels of development cannot explain the poor capability of the simulation. It is interesting to note that in this 9 year period when requests (i.e., "demands") are typically well above 3.0 MAF, the project has managed only slightly over 2 MAF per year in deliveries. How then are we to believe a simulation that grossly over estimates the capability of the project? Is this difference due to the assumptions DWR makes regarding the availability of local storage facilities?

In reality, many local entities have little or no storage means. If the local entity depends solely on SWP deliveries such that the amount depended on can not be delivered in any given year, then the amount depended on is not the reliable amount and the entity is at risk. If the local entity has say an end-of-line equalizing reservoir of fair capacity, that entity may be able to store several years of wet year deliveries to be used in periods of drought. The report presents several levels of drought; one year, two consecutive years, three consecutive years, on up to the longest prolonged droughts of six years. Using this data alone, one can deduce using mass balance how much storage is needed to balance deliveries, first through just the drought period so that the average shown in the report for that period is justified, or if a higher average is desired, how much storage is needed to accumulate wet year deliveries sufficient to obtain a higher average in the drought. In summary, it is the local entity and his facilities that determines how much SWP water can be counted on, not simply DWR's assumptions.

If the simulation's results as shown in the report are even close to accurate, it clearly shows that for many entities the average **dependable delivery will be close to 40%** (the averages shown for the two worst six year droughts) and even for this average there will of necessity be a requirement for some local equalizing storage. In instances, where SWP is the sole source of water, say for housing, the worst year of delivery is the dependable supply which according to the simulation's results is 19% but closer to 13% if the historical record is to be believed.

Two of the largest contractors as measured by Table A amounts are MWD and Kern County Water Agency (KCWA). Both of these entities have storage means, a large reservoir in the case of MWD and a large ground water basin for Kern. They may have capabilities to store substantial wet year deliveries for balancing against dry years. However, the report does not demonstrate that either of these is sufficient to produce a 75 or76% average delivery. And even if that could be shown, there remains the question of what the average deliveries would be for the remaining contractors. Just because MWD and Kern can achieve average deliveries is of little importance to the other contractors. In other words, there is no one average for the project that is appropriate for all contractors. It is presumptuous for DWR to so state.

Article 21 Water

A disturbing feature of the simulations is the instances during dry years where it shows Article 21 water being available. Article 21 water is interruptible and in effect is surplus water. The question is how can there be surplus water available during a dry year. We have learned that this quirk comes about because the model in this instance is not constrained by whether the year is going to be dry or not. The only criteria, as we understand them, are whether or not all Table A amounts at that instance in time are being met and if there is excess flow in the Delta that can be pumped. One of the requirements is that all the SWP reservoirs are full, a condition they try to achieve in the fall when the SWRCB allows heavy pumping if the year is not critically dry. The fall is too early to tell if the water year will be dry but the determination is established by whether the previous year was or was not critically dry. This allows the circumstance that heavy pumping may be allowed in the fall when heading into a dry year, but may very well result in filling the reservoirs, especially San Luis. Clearly, excess is evaluated against the SWRCB constraints.

But if it is reasonably guessed that the year will be dry, it seems more prudent to try and save this excess water to be released at a more propitious time, or find a different mechanism to declare the conditions for allowable pumping in the fall. One method of handling excess flow that comes to mind is to declare it Environmental water simply free to the environment. The history of the project to date has shown that the SWRCB rules are not adequate to protect fish; therefore assuming that because the SWRCB rules are met water can be declared excess is not in the best interests of the environment.

Carryover and Makeup Water

The report shows in its output summaries deliveries in categories of “Carryover” and “Makeup.” It is not clear how the SWP implements carryover since most of the operating criteria are geared to diversions when available. Is carryover water actually stored in either Oroville or San Luis? The same can be asked about “Makeup” water. Where does it come from? Is it subtracted from subsequent Table A deliveries? The report should explain these categories in terms that make the model outputs understandable.

We request that these comments and the responses to them by DWR become a formal part of the SWP Delivery Reliability Report as an appendix. These comments are submitted on behalf of the Citizens Planning Association of Santa Barbara County.

Respectfully submitted by:

Arve R. Sjovold

Arve R. Sjovold
Citizens Planning Association
916 Anacapa St.
Santa Barbara, CA 93101
(805) 966-3979